Pitting for Range Improvement in the Great Plains and the Southwest Desert Regions

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CONTENTS

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PITTING FOR RANGE IMPROVEMENT IN THE GREAT PLAINS AND THE SOUTHWEST DESERT REGIONS

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Mechanical treatments for moisture conservation and range improvement received considerable attention during the drought years of the thirties. Encouraging results during the period led to some intensive research. These studies developed facts as to the most effective mechanical treatments and the soil and vegetative limitations that affect the success of those treatments.

In 1938 the Soil Conservation Service, in cooperation with Dry Land Agriculture, former Bureau of Plant Industry, and the Wyoming Agricultural Experiment Station, set up a research program on mechanical treatments for range improvement at the Archer station in southeastern Wyoming. The work on shortgrass range was conducted both on small plots and on pastures where the value of treatments could be measured in terms of animal gain and grazing rates. Early results of this work led to more widespread use of various mechanical treatments in the northern and southern Plains and the Southwest desert areas.

Within these three geographic areas some differences in mechanical treatment methods and objectives have evolved. In the Southwest desert area pitting for moisture conservation to permit seeding and grass establishment is the major objective. In the Plains area the conservation of moisture and the encouragement of better mixtures of native grasses are the main objectives, with less attention being given to reseeding, particularly under northern Plains conditions.

Studies and observations of various range treatments show that benefits can be expected from treatments that provide closely spaced basins to hold excess water during torrential storms. Studies have also shown that the tillage treatment provides a renovation effect on the remaining plant cover as well as trapping and storing more water for plant growth.

Although various mechanical treatments have improved extensive range acreages, large areas still remain to be treated. Mechanical treatments on western rangeland vary, depending upon soil and cover conditions. The mechanical treatments are discussed separately for the northern shortgrass Plains, southern shortgrass Plains, and Southwest desert area. This bulletin summarizes studies and experiences in these areas so that the reader will be better able to fit pitting practices to his conditions and needs.

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NORTHERN SHORTGRASS PLAINS

Area Description

Mechanical treatment of rangeland in the northern Plains is usually most successful on the shortgrass plains, extending from northeastern Colorado across eastern Wyoming and Montana and in western Nebraska and the Dakotas. Generally the northern shortgrass Plains is characterized by a mixed short and midgrass cover made up of 50 to 75 percent blue grama interspersed with buffalograss. The rest of the cover includes western wheatgrass, needle-and-thread grass, June grass, some dryland sedges, and annual and perennial forbs. In some locations where pitting has been used, big sagebrush occurs in scattered stands. Pitting of dense stands of big sagebrush has generally not been considered in this study.

Mechanical treatments have been tested on soils that vary from clays to sandy loams and in some instances on gravelly and stony soils found in the mountains. The topography of the area ranges from flat and rolling to steep hillsides.

Annual precipitation ranges from 10 to 20 inches, with approximately three-fourths of this coming during the April-to-September period. Torrential rains that produce runoff are common during the summer season. Winter precipitation is in the form of snow, and in a large portion of the area much of the snow is blown off the range unless a good stubble cover is left.

Treatments and Implements Used

In the northern Plains pitting is the most common mechanical treatment used to improve range production. From the research work started in 1938, it was soon learned that furrows, pits, or other structures used to hold runoff water should be spaced close together. Various types of furrows, with spacings ranging from 2 to 30 feet apart, were studied, but only the spacings of about 2 feet produced consistent benefits. Pitting with an eccentric one-way disk with 16-inch spacing of disks proved to be as effective as grooved spacings 2 feet apart, and the disk was much easier and cheaper to use (fig. 1).

Another implement studied and finally discontinued was a chisel, or subsoiler. This implement, operated at 12- to 15-inch depths, heaved and loosened the soil below the surface with little actual surface disturbance except where the shank cut through the surface. This deep tillage implement was used on rangeland at spacing intervals 5 to 30 feet apart. It produced no significant improvement in the range forage in terms of cover and production.

Many implement variations have been developed in recent years for treating rangeland. Those treatments that produce a systematic thinning and general renovation effect and at the same time provide closely spaced basins for water retention appear to have done an effective job of range improvement.

Discussion of Results

In the northern shortgrass Plains pitting or similar mechanical treatments increase water intake and improve range vegetation. Pitting immediately stimulates plant growth and causes a gradual

FIGURE 1.—Ordinary one-way disk adapted for range pitting. Every other disk is left off, and the remaining disks are mounted at least 2 inches offcenter on the gang bolt by making a new hole in the disk for mounting. The long side of the disks are then mounted by quarter turns; first disk with long side down, the next one with the long side forward, and so on until all disks are in place. The seedbox shown here is not essential to pitting, but it may be used if seeding with pitting is needed.

change in species composition. The tilling and thinning effect of pitting generally gives immediate increase to the growth of the remaining plants. This thinning reduces the vegetation approximately one-third. All evidence indicates that on fair to good shortgrass range, the remaining two-thirds of the cover is enough to make full use of moisture and plant food, even the first year before other benefits from pitting have developed. During dry years thinning of shortgrass range by pitting often has a pronounced effect on growth of the remaining plants. The grass also remains green longer on the treated range.

The thinning of the cover is primarily the area of the pit. The sod slice cut out with the disk and thrown between the pits soon weathers down and acts as a beneficial mulch over the grass between pits. On typical soils of the shortgrass country studies of plant cover on pitted range have rarely shown any appreciable loss of cover due to excessive covering of the grass between pits. On heavy soils with dense sod some loss of cover might occur due to slow breakdown of the sod slice. However, dense sod is not typical of the shortgrass area where pitting is commonly done.

On shortgrass range, where at least a scattering of western wheatgrass is present, the thinning and tillage effect of the pitting stimulates the spread of this cool season midgrass within a year or two.

Figure 2.—Snow retention on adjoining fields: Upper view shows nonpitted range with shortgrass cover; lower view shows pitted range with increased cover of midgrasses that hold snow in place.

This result is one of the most important effects of pitting. Increased amounts of western wheatgrass add to the spring feed supplies and provide more ground protection than the shortgrasses. If the pitted range is properly grazed it consistently provides enough higher stubble to catch and hold significant amounts of snow during the winter (fig. 2). Western wheatgrass shows the greatest response of all grasses to mechanical treatment. However, improved soil moisture conditions benefit the other species present after some time.

Retention of runoff water is another important benefit of pitting (fig. 3). The amount of water held varies with the particular type of implement used. With the eccentric disk shown in figure 1, the actual holding capacity of the pits is 0.3 inch of water.

Tests were made in Wyoming in 1951 on rangeland pitted 6 years previously to determine water absorption rates. From a mobile infiltrometer used to apply simulated rainfall, it was found that pitted range absorbed 1.34 inches of water in 1 hour as compared with 0.68 inch on the nonpitted range. The average rainfall rate applied was approximately 1.5 inches per hour. With this storm intensity the pitted range allowed no appreciable runoff for 40 minutes as compared with runoff within 3 minutes on the nonpitted range. The water intake rate at the end of 1 hour was 0.82 inch per hour on the pitted range as compared with 0.43 inch per hour on the nonpitted range. The average intake rates over the 60-minute test period are shown in figure 4.

The increase in midgrasses as a result of pitting usually improves conditions so that all cool-season grasses benefit. Weed populations, however, do not increase appreciably on pitted areas as compared with adjacent nonpitted range. Weeds that are present frequently grow taller the first year or two after treatment, but in general are not important on pitted range. This problem would vary with the situation existing at the time of pitting. In general, the areas discussed represent range with a good cover of shortgrasses and a scattering of western wheatgrass and other midgrasses. Range seriously deteriorated with a predominance of weeds at the time of pitting would be expected to develop an increased weed population. Such range may require reseeding of grasses or other specific treatment.

In terms of production, pitted rangeland has increased perennial grass production 30 to 100 percent as compared with adjacent nonpitted range. The best measure of effect on production comes from the Archer Experiment Station in Wyoming, where grazing comparisons of pitted and nonpitted range have been made for 13 years. Wyoming Experiment Station Bulletin 344 reports on some of the earlier work and shows that for the 13-year period, pitted rangeland supported one-third more sheep per acre and produced 9.1 pounds more lamb per acre annually than did the nonpitted range (figs. 5 and 6). Thus, the original pitting operation increased the lamb gain about 120 pounds per acre over the 13-year period. Even with the heavier stocking rate on pitted range, the average amount of perennial grass left at the end of the grazing season was one-third greater on pitted than on the nonpitted range during the 13 years. These results were obtained from typical shortgrass range that was in "good" condition at the time of treatment in 1942. The range is situated on soil that varies from a sandy loam to a clay loam with topog-

FIGURE 3.—Pits made by disk shown in figure 1 will hold about one-third inch of water.

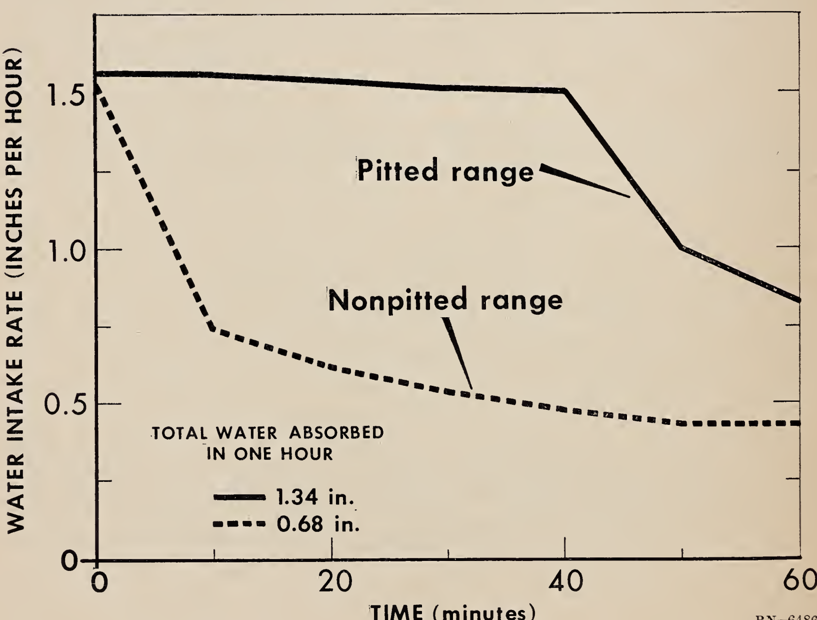

FIGURE 4.—Water intake rates on pitted as compared to nonpitted rangeland under simulated rainfall for 1 hour.

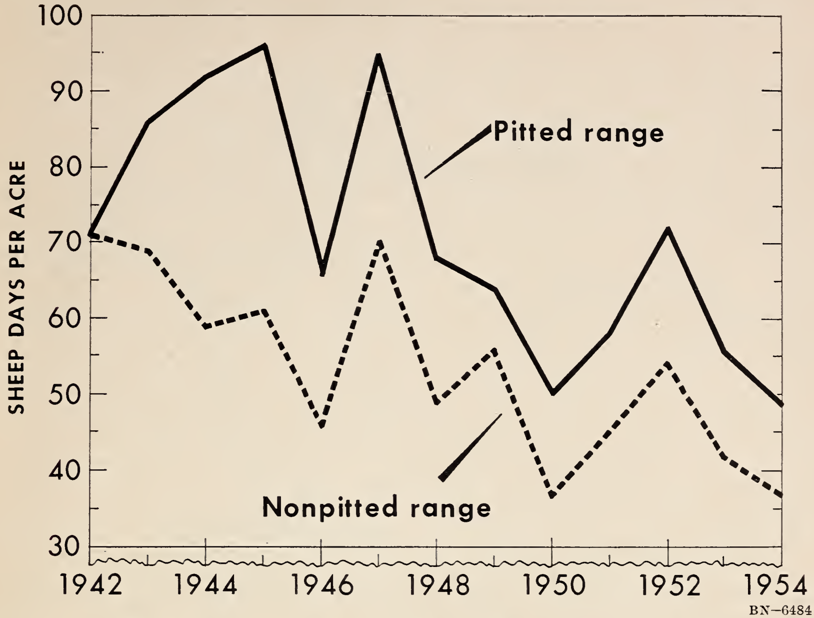

FIGURE 5.—The 13-year average stocking rate was 71 sheep days per acre on pitted range as compared with 53 on nonpitted range. Animal gain per head was about equal on all pastures. Thus, with one-third higher stocking rate the animal gain was about one-third higher on pitted range than on nonpitted range.

raphy ranging from relatively flat to slopes of 10 percent. Duplicate pitted and nonpitted pastures were studied.

The life of the pits varies with the soil and cover conditions. With sandier soils and sparse vegetation the life of the pits is much shorter than on finer textured soils with denser stands of grass. Therefore, with very sandy soils and sparse vegetation, pitting would not pay. Under the usual soil and vegetative conditions existing over the northern shortgrass Plains, the pits and their overall effects can be expected to last at least 10 years. At the Archer station pitted rangeland in the 13th year continued to show some of the plant composition changes brought about by the treatment, although the water-holding capacity of the pits had largely disappeared in the 10th or 11th year.

Seeding grass or legumes with a pitting operation has not been successful in the northern Great Plains. The problem seems to be simply too much competition during the dry summers from the native plants remaining after pitting. Under very favorable seasonal moisture conditions or in a few instances where the existing native cover was extremely thin, a few satisfactory seedings of crested wheatgrass have been established. In general, seeding with a pitting operation on shortgrass range in this area is not recommended.

Time of year for applying a pitting treatment has had limited study. All indications point to very early spring as the ideal time to pit; if possible, before plant growth starts. However, there has

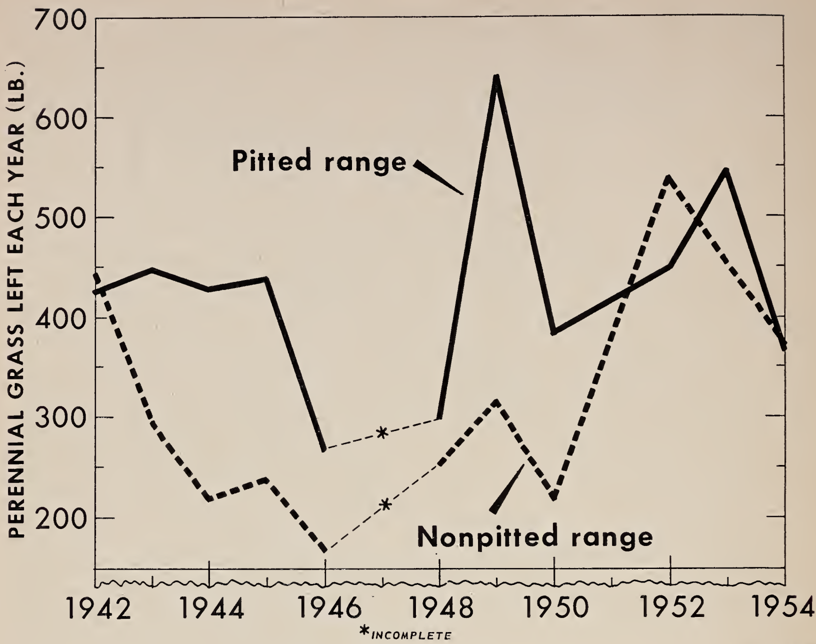

Figure 6.—An average of 426 pounds per acre of grass was left on the pitted range at the end of each grazing season over the 13-year period, as compared with 319 pounds per acre of grass on the nonpitted range.

actually been little apparent difference among fall, winter, or spring treatments. The principal advantage is that in the spring the soil is generally moist and pits cut out more readily. Also, on the lighter soils fall or winter pitting may allow more soil blowing during high winds. However, in the shortgrass area this loosened soil is usually tied down well enough with roots to minimize soil blowing, and soil blowing is a minor problem regardless of the time of pitting.

No research has been conducted in the northern shortgrass Plains on when to begin grazing after pitting. The pasture studies reported were grazed within 6 weeks after pitting and for the full season that year. The question of whether or not to graze the year the area is pitted does not appear to be critical. Pitting simply thins an established stand of native grasses; all the remaining plants after the pitting are well established and are generally more vigorous after pitting than before. If grass is seeded into the pits, however, protection of the seedlings would be necessary for at least a year. Deferment of grazing the first year following pitting would be expected to produce benefits similar to deferred grazing of nontreated range and to that extent would be worthwhile. It is presumed that grazing is moderate at all times.

One of the practical objections to range pitting has been the rough condition created for vehicles. Since one main objective of the treatment is to provide a means of catching and holding water, there is little that can be done to overcome this objection. In some cases pit-

ting in strips or skipping strips at reasonable intervals might minimize the problem.

Other limitations are related to the selection of the site to be pitted. In semidesert conditions with sparse cover and very sandy soils or in areas with dense stands of sagebrush, little benefit from pitting or similar treatments has been found.

The cost of pitting may limit its use. However, pitting as described here involves a cost of $1 to $2 per acre, which is low in relation to the returns received.

Conditions Affecting Success of Treatments

In planning a pitting treatment for this northern area, the operator should consider that (1) any variation from the type of pitting described here should aim to give a surface coverage similar to the pitting with the eccentric disks set at 16-inch intervals; and (2) the treatment should provide a relatively long-lived basin or obstruction that holds back runoff water as contrasted with a treatment made by a deep chisel or ripper that loosens below the surface.

Within the range of soils where the so-called shortgrass type of Plains cover occurs, rangeland pitting has commonly benefited forage production. From the standpoint of water conservation all evidence shows that more water can be held by pitting regardless of range condition. Forage production, however, has shown limited benefit on rangeland in poor condition. Such range could be considered for reseeding either with pitting or by complete seedbed preparation and seeding. Pitting has not been very successful on light sandy soils or on wheatgrass bottomlands. On steep slopes occasional difficulty may be experienced in operation of equipment for pitting.

SOUTHERN SHORTGRASS PLAINS

Area Description

The southern Plains extend eastward from the eastern front of the Rocky Mountains in Colorado and New Mexico into western Kansas, the Oklahoma Panhandle, the Texas Panhandle, and the Edwards Plateau in western Texas. In this extensive plains area, average annual precipitation ranges from 10 to 22 inches. One of the major hazards to stable land use within the southern Plains is the dramatic recurrence of prolonged drought periods. The drought of 1934–39 and the drought of 1950–57 have resulted in severe wind erosion, land deterioration, and economic hardships.

Rangelands within this area are generally used the year-round. By far the most common kind of rangeland consists of rolling uplands with medium-textured soils that support a mixture of shortgrasses and some midgrasses. Principal shortgrasses are blue gramagrass and buffalograss. Midgrasses include sideoats grama, galleta, tobosa, and sand dropseed in the southern areas and western wheatgrass and needle-and-thread grass in the northern part of the southern Plains.

Owing to the combined effects of past grazing use and repeated drought, much of the rangeland consists of a mixture of shortgrasses, half-shrubs, and various other weedy plants. By 1957 surface soil

and plant cover conditions had deteriorated to the point where runoff rates were high and water intake rates were low. Many pastures have a surface crust that hinders moisture penetration and restricts seedling establishment.

Treatments and Implements Used

The two most commonly used implements for range pitting in the southern Plains are the eccentric disk and, more recently, the rotary pitter. The eccentric disk is in general use in western Texas, while the rotary pitter has been used principally in eastern New Mexico and eastern Colorado. Most of the eccentric disks in use are modifications of the common one-way plow or consist of individual disks mounted on a toolbar. Generally about 5 inches are cut away from one side of the disks, which are placed on the axle to obtain a 3- to 4-foot spacing. If the disks are 24 to 30 inches in diameter, the pits made by this equipment are generally 3 to 5 feet long and 3 to 6 inches deep. The width of the pit depends primarily on the angle at which the plow is set. If seeding is to be done at the same time as the pitting, a seedbox is usually mounted on top of the disk.

Various types of rotary pitters and subsoilers produce a small basin for water retention. The depth of penetration of the teeth depends upon soil condition and weight being carried on the implement (figs. 7 and 8). The implement in figure 7 uses weights added to the gang bolt, and that shown in figure 8 is a drum in which water

FIGURE 7.—A rotary pitter with weights added to gang bolt, developed for use on the southern Great Plains.

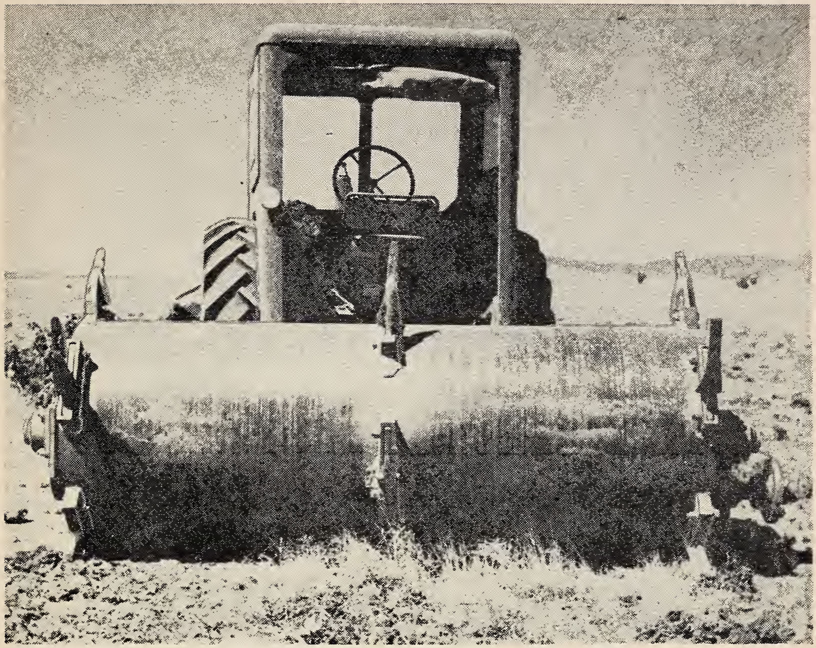

FIGURE 8.—Rotary pitter developed in Central Colorado Soil Conservation District consists of an 8-foot steel drum with 3 rows of teeth 4 feet apart and five 14-inch teeth in each row. The pitter makes about 5,000 pits per acre with a water-holding capacity of 3 or more gallons each.

may be added for weight to obtain the desired penetration. Spacing of pits can be varied, but spacing is commonly at 4-foot intervals between rows of pits.

Both eccentric disks and rotary pitters are used principally to increase moisture penetration. However, seeding of depleted rangelands with adapted species is a common practice, particularly in connection with the use of the eccentric disk, or cutaway disk (fig. 9).

Discussion of Results

Range pitting has served as a stimulus to plant growth in most cases in the southern Plains. The degree of response is highly variable, owing to a number of factors. In a recent study made in western Texas by the Texas Agricultural Experiment Station,[1] pitting, using an eccentric disk, was done with and without reseeding. Pitting without reseeding increased moisture penetration and stimulated plant growth. In addition, some natural reseeding of native grasses was evident. Reseeding at the time of pitting, using sideoats grama, was successful on upland soils. Pitting alone and pitting with re-

[1] THOMAS, GERALD, and YOUNG, VERNON. RANGE PITTING AND RESEEDING TRIALS ON TEXAS STATION NEAR BARNHART. Tex. Agr. Expt. Sta. Prog. Rpt. 1882. 5 pp. 1955.

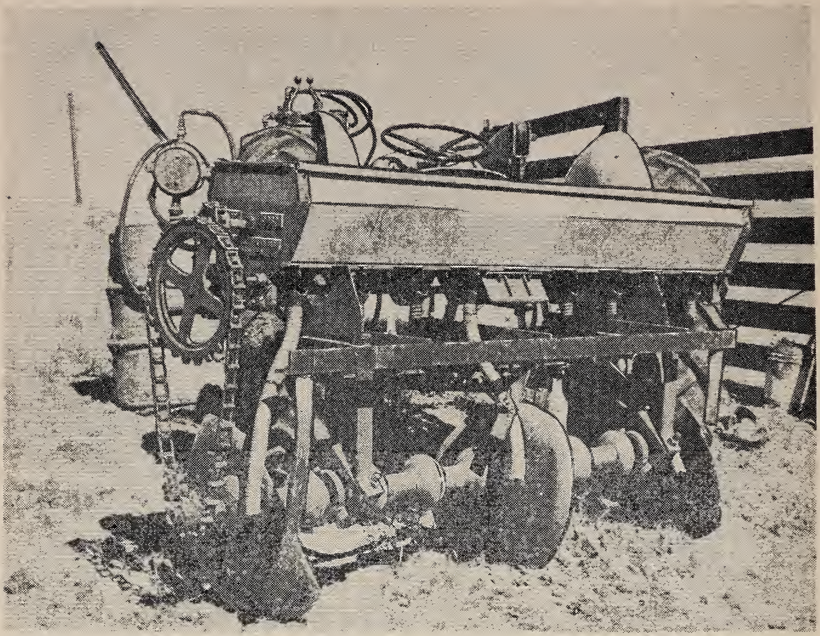

Figure 9.—An adapted one-way disk for pitting and seeding. A 5-inch slice has been cut off each disk, and the disk mounted in every third position on the gang bolt. Pits are 5 inches deep and 30 inches apart. Seedbox provides for reseeding with pitting operation.

seeding was less effective on finer textured soils on tobosa flats and old lake beds than on upland soils (figs. 10 and 11).

Range pitting, using a rotary pitter, increased moisture penetration and forage production in east-central Colorado. On clay loam soils covered with a moderate stand of blue grama and galleta grass, moisture from 0.75-inch rain penetrated to a depth of 19 inches in the pitted area as compared with 7 inches in an adjacent unpitted area. On this particular area forage production was doubled on the pitted area as compared with the unpitted area during the first year in which yield studies were made. Rotary pitting with an implement, such as shown in figure 7, penetrates deeper than disk pitting and may produce greater benefits than the more shallow disk pittings on soils with impervious layers within the top foot.

Conditions Affecting Success of Treatments

The purpose of any mechanical treatment on rangeland is to aid in the establishment of the kind of plant cover that will provide a permanent protection to the soil and produce a high forage yield. Therefore, it is essential that proper grazing use and management be applied on treated areas following pitting operations.

The need for and effectiveness of pitting vary considerably with the kind of soil and the condition of the plant cover. Soils on which water intake is naturally high, such as deep sands, should not be pitted. Soils finer in texture than sandy loam, with insufficient plant

Figure 10.—This depleted range, Edwards Plateau Soil Conservation District, Sonora, Tex., was pitted and seeded with the buffalograss, blue panicum, sideoats grama, and King Ranch yellow bluestem in March 1955.

Figure 11.—Same range as in figure 10 in September 1955. An excellent stand and growth of seeded grasses developed following the pitting and seeding operation in March.

cover and plant residues to insure satisfactory water intake rates, frequently benefit from pitting. Pits are most easily constructed on level to rolling topography, but may be constructed on steeper slopes. Equipment is more difficult to operate on steep slopes, and rocks and brush may also prevent effective pitting operations.

Most pitting in the southern Plains is done on rangelands supporting shortgrasses. However, many of these rangelands can and do support midgrasses. If midgrass species are already present in the area to be pitted, the operation may stimulate their growth. If these species are absent, they frequently can be reseeded in connection with pitting operations. Sideoats grama is often reseeded in the southern part and western wheatgrass in the northern part of the southern Plains. The added moisture furnished by pits is utilized by whatever plant cover or seed source is readily available. If pitting is done on weedy rangeland, increases in weed growth may follow pitting. For this reason, seeding of grasses with the pitting may be advisable on very weedy rangeland.

Pitting is most beneficial when completed in that part of the growing season which in average years immediately precedes the period of highest rainfall. Thus, the time of year for pitting will vary with locality, but generally it will be from spring to midsummer.

The effective life of pits is quite variable. Because of their greater size, pits constructed with eccentric disks last longer than pits constructed with a rotary pitter. Washed-in or blown-in soil may reduce the effective life span of these basins. Rapid development of a plant cover aids materially in extending the effectiveness of the pits.

SOUTHWEST DESERT AREA

Area Description

The desert grassland areas extend from western Texas to southern Arizona and range in elevation from 1,000 to 5,000 feet. Soils vary in texture from coarse sands to clays. Many are limy, with low rates of water intake.

The vegetation is composed of such desert grasses as bush muhly, black grama, tobosa, and cottontop, associated with creosotebush, mesquite, burroweed, and cacti. There are also many annual weeds and grasses.

The area has low and uncertain rainfall, averaging 8 to 18 inches annually. One-half or more of this precipitation falls during the summer season, usually as intense short-time thunderstorms. A large part of this moisture is lost as runoff under deteriorated range conditions, owing to surface sealing of the soil.

Reseeding is usually required to bring about any great improvement in grass cover and production within a reasonable time on areas that have deteriorated to poor condition.

Treatments and Implements Used

Pitting as a combination of seedbed preparation and a water conservation measure in southern Arizona and western Texas provides for more positive establishment of range seedings. Different types

of equipment were tried that could leave the soil in a condition to trap and store the maximum possible amount of rainfall.

Mechanical means to reduce competition of both annual and perennial plants has also been a major requirement. The wheatland plow modified for pitting has heretofore most nearly met these qualifications. Eccentric and cutaway disk arrangements have both been used. More recently a disk that makes larger pits for water storage appears to be a better implement, particularly on the drier sites and on the more impermeable soils.

Several variations of the pitting equipment mentioned above have been tried from time to time and have been discarded for one reason or another. Two of the implements that were tried and discarded were: (1) The small 3-point hitch, one-way disk with cutaway disks that often lacked the weight to penetrate hard ground and produced small narrow pits, which soon filled with soil and became ineffective; (2) the heavy-duty offset disk modified for pitting, which was difficult to regulate for depth of treatment and produced a loose unsatisfactory seedbed.

Discussion of Results

Pitting is one of the most effective and economical methods of preparing a seedbed and for trapping and holding water. It also provides a relatively firm seedbed and assists in the control of competing vegetation (fig. 12).

In southern Arizona and western Texas a pitted seedbed will enable establishment of a stand of grass in comparison to a complete failure on nonpitted control areas. These differences are mainly

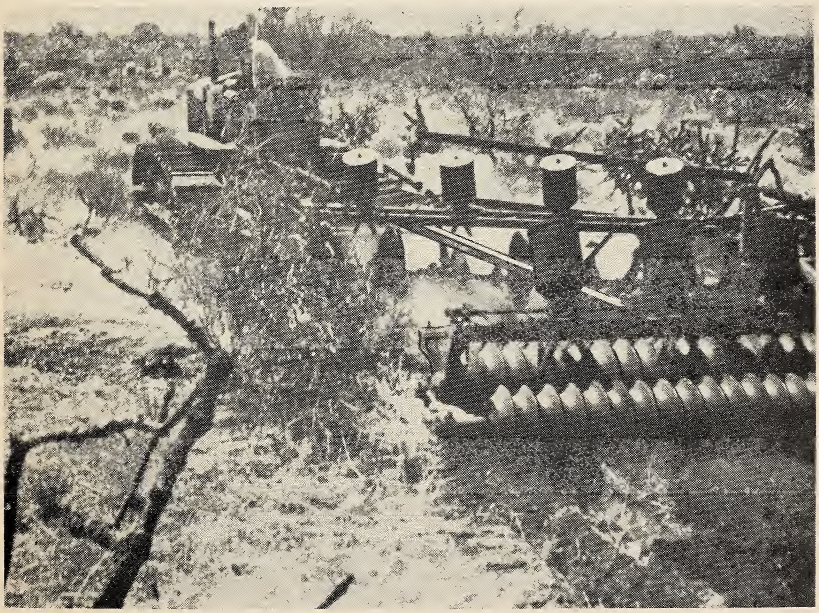

FIGURE 12.—One-way disk converted for pitting, followed by seeding and packing operation, for use in Arizona.

caused by the differences in water conservation. Actual water storage capacity per acre for the pitted area will vary with the size and spacing of the pits, but generally ranges from 0.3 to 0.6 inch per acre. The disturbance of the soil by pitting also increases the rate of water penetration. Another value of pitting in seedbed preparation is that water concentrates in the bottom of the pits and thus greatly increases the chances for successful establishment of the seeded grasses.

Seeded stands of Boer or of Lehmann lovegrass have consistently yielded 700 to 1,000 pounds of air-dry forage per acre, in comparison to 300 to 400 pounds per acre produced by weedy annuals on untreated range.

A good pitting job in the Southwest desert area is usually effective for 3 to 5 years, depending on the size and shape of pit and the type of soil. Rapid reestablishment of vegetative cover also adds materially to the life of the pit.

Pitting has its limitations, and it is well to recognize this before any treatment is planned. Pitting is not practical on land that is extremely rocky or has heavy infestations of large brush. It is not recommended in the Southwest on slopes greater than 8 percent.

Conditions Affecting Success of Treatments

Pitting is usually more effective on soils of medium to heavy texture in the Southwest desert area. Loose, sandy soils are not greatly benefited by treatment. Water intake rates are usually high on such soils and it is also difficult to produce well-defined, long-lasting pits. Gently sloping or slightly rolling land is best suited to pitting. Such treatments have been most effective on the desert grassland and are ordinarily applied to these ranges when in "poor condition." The best time for treatment and seeding is May and June, preceding the summer rains.

Pitting and seeding on deteriorated rangeland are not the entire answer to recovery. These rangelands must be protected from grazing for at least two growing seasons after planting to enable the seedling grasses to become well established. Grazing management thereafter must be conservative and well planned; otherwise, the land will revert to a deteriorated condition and the expense and effort expended on improvement will be wasted. It is highly desirable to have the seeded area fenced as a separate unit so the grass can be used at the proper season for maximum benefit and without damage. This is especially true with some of the introduced species, which have a considerably different season of growth than the native species that may occur on adjacent areas of native rangeland.

SUMMARY

Pitting for range improvement and water conservation is effective over a wide range of soil and climatic conditions. Some variations in type of pitting are required in different areas of the West to meet different cover, soil, and climatic conditions. Research and field experience have been summarized for northern and southern Great Plains conditions and for the Southwest desert area.

Range pitting with disks that gouge out small, closely spaced basins has increased grazing capacities and per-acre animal gains considerably and at the same time provided a greater carryover of grass from one grazing season to the next.

Range pitting has significantly increased water absorption rates into the soil during rainstorms that exceed the water-intake capacity of the normal soil condition. The pits provide a holding capacity of ⅓ to ½ inch of water, as well as creating a condition that favors higher water-intake rates.

Range pitting on the shortgrass plains, particularly in the northern parts, has stimulated the spread and development of western wheatgrass and other cool-season midgrasses. These grasses provided a better variety of feed, particularly in the spring season, and when the range is properly grazed it affords greater stubble, which catches snow and benefits future production.

The effective life of pits varies with the soils, type of implement used, and grazing management. Pits made with a disk implement on shortgrass range that is moderately grazed have generally been effective about 10 years in terms of waterholding. Plant composition changes that occur with pitting have persisted longer. Pits on a range with loose or sandy soils with sparse cover have a shorter effective life. In the Southwest desert area, pits are generally ineffective for water retention after 4 or 5 years.

Notched, cutaway, and eccentric disks have been the most commonly tested implements for range pitting. However, rotary pitters that produce a smaller but deeper pit are especially successful in parts of the southern Great Plains on certain soils with impervious layers 6 to 12 inches below the surface. Loosening and opening this layer with a long tooth on the rotary pitter has brought about significant improvement in water absorption.

Seeding grass with the pitting operation has generally been unsuccessful in the northern Plains. In some parts of the southern Plains and under Southwest desert conditions, seeding and reestablishment of perennial grass cover have been successful and are the major objectives of the mechanical treatment program. Treatments are not recommended for very light soils or for steep slopes. In the northern Plains wheatgrass bottomland has shown little benefit from pitting. Pitting will have other local limitations, and range users are urged to consult local advisers who have had experience with this type of range improvement practice.

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